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CONTROL OF THE NICOLET 446B SPECTRUM ANALYSER VIA THE IEEE-48 B--ETC(U)
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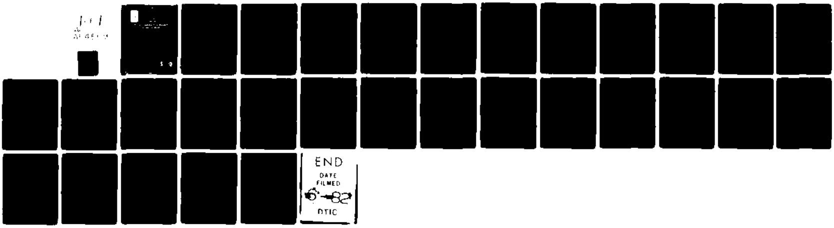

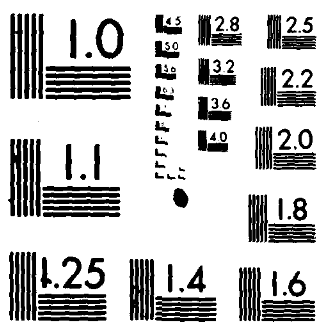

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RSRE MEMORANDUM No. 3445

ROYAL SIGNALS & RADAR ESTABLISHMENT

CONTROL OF THE NICOLET 446b SPECTRUM ANALYSER VIA THE IEEE-488 BUS USING AN HP-85 DESK-TOP COMPUTER

Author: Paul A Manning

PROCUREMENT EXECUTIVE,
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ROYAL SIGNALS AND RADAR ESTABLISHMENT

Memorandum 3445

TITLE: CONTROL OF THE NICOLET 446b SPECTRUM ANALYSER VIA THE IEEE-488 BUS USING AN HP-85 DESK-TOP COMPUTER

AUTHOR: Paul A Manning

SUMMARY

Software has been written to provide automatic control and data acquisition facilities for the Nicolet 446b spectrum analyser. Information is provided to enable use of the software as it stands, or for the user to modify it to his own needs.

This memorandum is for advance information. It is not necessarily to be regarded as a final or official statement by Procurement Executive, Ministry of Defence

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CONTROL OF THE NICOLET 446b SPECTRUM ANALYSER VIA THE IEEE-48 BUS USING AN HP-85 DESK-TOP COMPUTER

Paul A Manning

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1 INTRODUCTION

In order to verify theoretical predictions for the noise spectra in CCDs operating in the weak-inversion mode[1], it has proved necessary to make measurements of noise to a high degree of accuracy over the frequency range of a few hertz up to tens of kilohertz. The measurement of noise to high accuracy requires that results be averaged or integrated over a long period of time. Such measurements are obviously suited to a computer-controlled system, such as the one described here.

The Nicolet 446b spectrum analyser has as an opt... IEE-488 bus interface[2] which permits complete control and sensing o... analyser functions, and permits the transfer of data, via the bus.

The HP-85 desk-top computer also has an IEEE-488 bus option, which together with an extra read-only memory (the I/O ROM)[6] permits easy manipulation of the bus using a small set of instructions not included in the standard Hewlett-Packard basic language[5].

This memorandum describes a computer program written with the above aims and constraints in mind, to provide complete control and sensing of analyser functions, and the ability to store data onto magnetic tape cassettes.

2 PROGRAM STRUCTURE

The program is stored as three separate sections on cassette, in order that it will fit in the basic 16K-bytes of computer memory. These three parts are listed as appendices 1, 2 and 3, with a flow diagram (fig 1) to show the operation of the whole program.

2.1 Initialisation

The bus identification code entered via the keyboard enables the computer to establish communication with the analyser via the bus. The user then chooses the next course taken by the program, which is essentially a choice between sections 2.2 and 2.3.

2.2 Keyboard Control

The user is presented with a sequence of "menus" enabling him to select in turn a group of controls, an individual control with its current setting displayed, and all possible settings of the control chosen; and to change the control setting as desired. This process continues until the user chooses to store some data.

2.3 Data Storage

The user chooses whether he wishes to store the current data being displayed by the analyser or to allow the computer to control data acquisition to his requirements.

In the first case the computer decides on the type of data being displayed, initialises a data file on a cassette accordingly, and stores the data on the tape.

In the second case, the user feeds his requirements in via the keyboard, and the computer decides on the best way to take the distribution of spectral points requested. This is particularly important when the spectrum analyser is fitted with the "frequency expansion" option[3], when the origin of a narrow band of frequencies can be selected to occur at any frequency within the analyser's range, thus enabling a small frequency resolution at high frequencies. The computer sets up suitable ranges for the analyser, initialises a data tape file as above and after the analyser has finished its data acquisition and averaging the data is transferred to the computer, the selected data points being stored on tape. This process is repeated if it is necessary to sweep the frequency expansion origin until the data has all been acquired.

3 SPECIAL COMMANDS

There are a number of commands peculiar to this particular combination of machines which will now be described in some detail. These relate to the transfer of instructions or data via the IEEE - 488 bus[7].

In all the subsequent examples, the number denoted 'N' is the address code of the analyser. It is an integer in the range 700-731 where the "7" indicates the IEEE - 488 bus and the integer 0 - 31 is the code set up on the rear panel of the spectrum analyser by the user.

OUTPUT N; A$

This command sends an instruction to the analyser, the details of which are defined by the character string "A$".

A$	Instruction sent.
"L"	Returns spectrum analyser to local (ie front panel) control.
"S"	Instructs the analyser that the next information to be transferred from the analyser is the sensing of the current control settings.
"T"	Instructs the analyser that the next information to be transferred from the analyser is time or spectral data depending on the current display.
"XXXXX"	A 5 character hexadecimal representation of a 20 bit binary number which represents the 20 bit internal bus architecture of the spectrum analyser[4]. Bits 1 to 16 define the control settings, and bits 17 to 20 identify the set of controls to which the instruction refers.

ENTER N USING "%, %K"; A$

This command sends data from the spectrum analyser to the computer, the nature of the data being defined by a previous OUTPUT statement. The character string A$ is a 5 character hexadecimal representation as above, containing either the current control setting, or data acquired by the analyser. The statement 'USING "%,%K"' is an IMAGE statement which defines the format of the data transfer[8]. It enables the spectrum analyser's end-of-transfer character (control 'C') to be interpreted correctly and thus complete the bus handshake procedures necessary at the end of a transfer of data.

4 TAPE STORAGE FORMAT

Along with the data stored by the program on tape cassettes, there is stored some other information in order to aid subsequent analysis of the data. This format is dependent on the type of data which has been stored. Once data has been stored on tape, it may be processed by another program to give data of any desired format. Below is listed the order and character type of the data as stored onto the tape cassette.

a) Time data as displayed

Character	Meaning
A$	"T" - time data.
A	1024 - no of data points in data file.
B$	Up to 40 characters of information entered by the user from the keyboard.
B	Bandwidth of complete spectrum (Hz).

Character	Meaning
C	Lowest frequency component of spectrum (Hz).
D(1024)	1024 data points in terms of voltage (V).

b) Spectral data as displayed

Character	Meaning
A$	"S" - spectral data.
A	400 - no of spectral data points in data file.
B$	Up to 40 characters of information entered from keyboard.
C$	"HANN" or "FLAT" or "AUTO" - form of spectral weighting applied to data.
B	Bandwidth of complete spectrum (Hz).
C	Lowest frequency of spectrum (Hz).
D	Spectrum analyser reference voltage (V).
E(400)	400 spectral data points (V).

c) Spectral data acquired under computer control

Character	Meaning
A$	"LIN" or "LOG" - Spectral data acquired under computer control: logarithmic or linear frequency spectrum.
A	Number of spectral data points taken.
B$	Up to 40 characters of information.
B	Filter bandwidth for single spectral point (Hz).
C	Number of sample averages taken.
D(A) E(A)	Ordered pairs of numbers giving measurement frequency (Hz) and spectral amplitude (V).

5 CONCLUSION

This memorandum is intended to enable anyone wishing to use this combination of machines to form a computer-controlled data acquisition system, to use this particular program, or to simply modify it to their own needs. The explanation given here will suffice for anyone with a working knowledge of Hewlett-Packard basic, and with the aid of manuals for the equipment, to understand the functioning of the program; a complete listing of which, together with some annotation, is given in the appendices. In order to use the program as it stands, however, such knowledge is unnecessary, thus providing a tool for the user who does not wish to involve himself in the mechanics of device operation, but wishes only to gather data.

REFERENCES

1. R Watton et al, "Direct Charge Injection for the Pyroelectric/CCD Hybrid", Proc. Int. Conf. Advanced Infrared Detectors and Systems, IEE London, 1981, pp 82-87.

2. "Instruction Manual for Model 446 FFT Computing Spectrum Analyser", Nicolet Scientific Corporation USA, 1980, pp 5-86, 5-123.

3. Ibid. pp 8-1, 8-5.

4. Ibid. pp 5-24, 5-61.

5. "HP - 85 Owner's Manual and Programming Guide", Hewlett-Packard Co, USA, 1979.

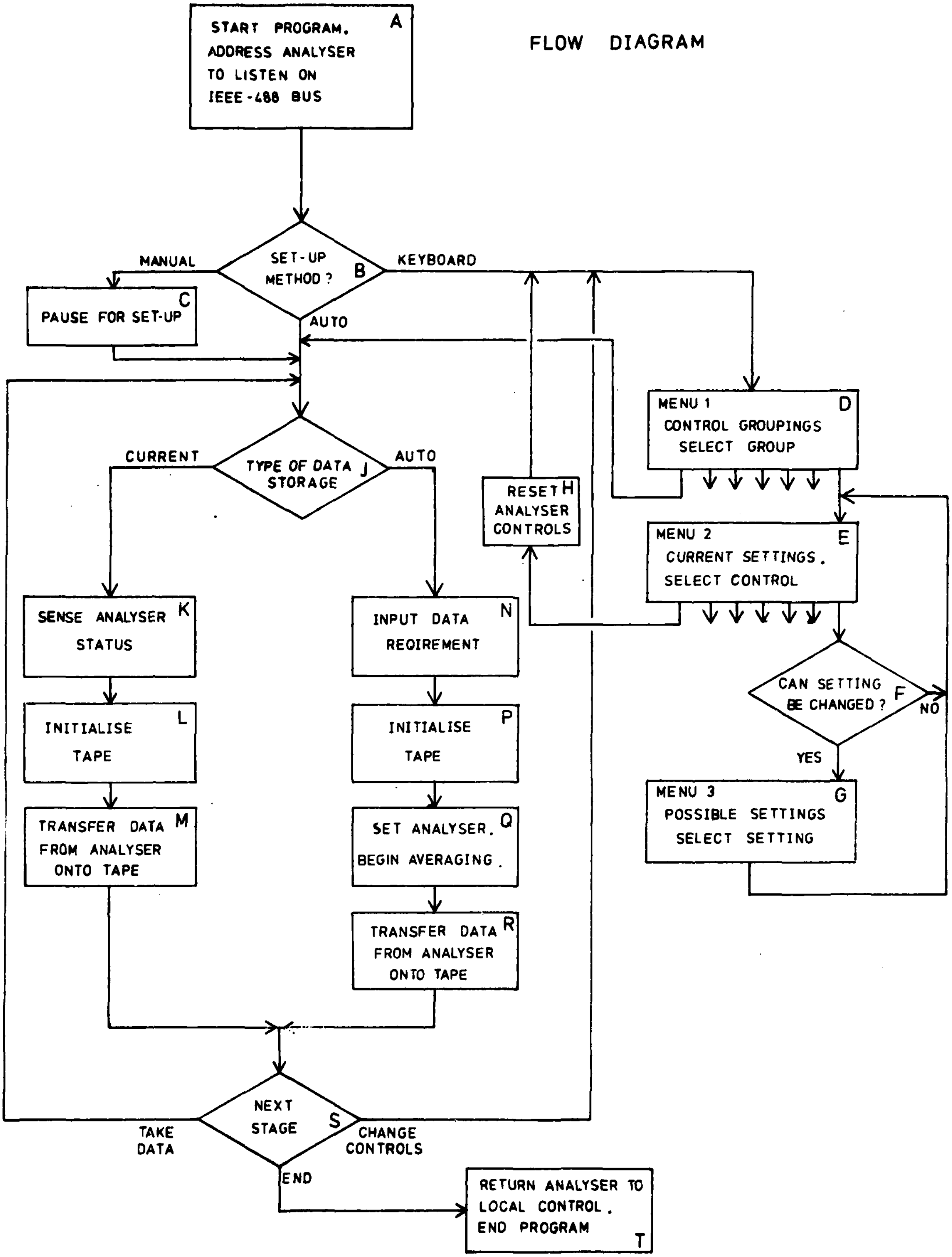
6. "HP - 85 I/O Programming Guide", Hewlett-Packard Co., USA, 1980, Section 12.

7. Ibid. pp 227-282.

8. Ibid. pp 25-27.

FIG 1

FLOW DIAGRAM



LETTERS 'A' TO 'T' CORRESPOND TO LETTERS IN APPENDICES 1,2 AND 3

LIST OF SYMBOLS

A$, B$ etc	String variables in computer memory comprising alphanumeric characters.
A,B, etc	Numeric variables in computer memory.
A(N), B(N) etc	1-dimensional numeric array variables with N elements in the array.
X	A hexadecimal digit 0 through F.

APPENDIX 1

```
1000 COM INTEGER N,S1(10)
1010 ENABLE KBD 229
1020 CLEAR
1030 DISP "  NICOLET 446B spectr
     um analyser"
1040 DISP "control and data aqui
     sition"
1050 DISP "software."
1060 DISP "                    P A.
     Manning"
1080 DISP USING 1230 ; "   Crown
      Copyright (C) 1981"
1090 WAIT 5000
1140 CLEAR @ DISP "Give the code
      switch setting"
1150 DISP "selected for the NICO
     LET"
1160 INPUT S1
1165 SET TIMEOUT 7;3000
1166 ON TIMEOUT 7 GOTO 1300
1170 N=700+S1 @ S=SPOLL(N)
```

Check that device specified is present.

```
1200 ON KEY# 1,"LOCAL" GOTO 2000
1210 ON KEY# 4,"HP-85" GOTO 2080
1220 CLEAR @ DISP USING 1230 ; "
     Mode of control for NICOLET
      "
1230 IMAGE 8/,K
1240 KEY LABEL
1250 GOTO 1250
1300 CLEAR @ DISP "Device no.";N
     ;"not present "
1305 ABORTIO 7
```

If device is absent, then terminate program operation.

```
1310 DISP "Program terminating."
1320 END
2000 OFF KEY# 1 @ OFF KEY# 4
2010 ON KEY# 1,"READY" GOTO 2200
2020 KEY LABEL
2030 DISP "Spectrum analyser und
     er local"
2040 DISP "control."
2050 DISP USING 1230 ; "Press ke
     y when analyser is set"
2060 DISP "up as required"
2070 GOTO 2070
2080 CLEAR @ DISP "  Please be p
     atient whilst"
2090 DISP "the rest of the progr
     amme "
2100 DISP "is being initialised"
2105 WAIT 5000
2110 CHAIN "NIC #2"
2200 REMOTE N
2205 OUTPUT N ;"S" @ K1=0
2210 ENTER N USING "%,%K" ; S1$
2215 IF S1$="N" THEN 2240
2220 S1(K1)=HTD(S1$[1,4])
```

Address analyser to listen. Send instruction requesting control setting data, and read data into computer as integer array S1(K1)

```
2225 K1=K1+1 @ GOTO 2210
2240 CLEAR @ DISP "  Be patient
     whilst next program is bein
     g initialised"
2245 WAIT 5000
2250 CHAIN "NIC #3"
```

```
100 ENABLE KBD 229
110 OPTION BASE 0
120 DATA "0","1","2","3","8","9"
    ,"A","C","D"
900 INTEGER L(15),K(15),L1,L2,L3
    ,L4,L5,K1,K2,K3,K4,K5,S1,S2,
    S3
910 COM INTEGER N,S1(10)
920 SHORT A2
1100 DEF FNC2(A$)
1110 C1=BTD(A$) @ C3=2^LEN(A$)
1120 C4=C3/2-.5 @ IF C1>C4 THEN
     C1=C1-C3
1130 FNC2=C1 @ FN END
```

2's complement conversion routine

```
3000 CLEAR @ DISP " Front panel
     control and sense"
3015 WAIT 2000
3020 REMOTE N @ LOCAL LOCKOUT 7
3030 OUTPUT N ;"S" @ K1=0
3040 ENTER N USING "%,%K" ; S1$
```

Address analyser to listen.
Sense control status.

```
3050 IF S1$="Ñ" THEN 3090
3060 S1(K1)=HTD(S1$[1,4])
3065 K1=K1+1 @ GOTO 3040
3090 DISP "  Which controls do y
     ou wish"
3100 DISP "to sense or change"
3110 DISP
3120 DISP "0 : DISPLAY,MODE,SCAL
     E,PLOTTER"
```

Menu 1 : control groupings.

```
3130 DISP "1 : INPUT,TRIG,FREQ,W
     INDOW"
3140 DISP "2 : CURSOR,DISPLAY,ST
     ORE"
3150 DISP "3 : CONT/HOLD,I/P AMP
     ,FREQ EXP"
3160 DISP "4 : FREQ. EXPANSION O
     RIGIN"
3170 DISP "5 : REFERENCE VOLTAGE
     "
3180 DISP "6 : VERT SCALE,MARKER
     ,INT/DIF"
3190 DISP "7 : CURSOR LOCATION"
3200 DISP "8 : No. OF AVERAGES"
3205 DISP "9 : NO CHANGE OF SETT
     INGS"
3210 DISP
3220 DISP "  Select control";
3230 INPUT S2
3240 ON S2+1 GOSUB 5000,5300,560
     0,5900,6200,6500,6800,7100,
     7400,4000
4000 CLEAR @ DISP "  Data aquisi
     tion and storage"
4005 DISP @ DISP "Current spectr
     al or time data"
4010 DISP "may be stored,or furt
     her data "
4015 DISP "may be aquired under
     HP-85      control"
4020 DISP @ DISP "K1 for storage
      of data"
```

```
4025 DISP "K2 to disable compute
     r control"
4030 DISP "K3 to continue comput
     er control"
4035 ON KEY# 1 GOTO 40[illegible]
4040 ON KEY# 2 GOTO 4500
4045 ON KEY# 3 GOTO 3000
4050 GOTO 4050
4055 CLEAR @ DISP "  Data storag
     e programme being"
4060 DISP "loaded,please be pati
     ent"
4065 WAIT 5000
4075 CHAIN "NIC #3"
```

Returning analyser to local control.

```
4500 DISP "Spectrum analyser ret
     urning to"
4505 DISP "local control"
4510 OUTPUT N ;"L"
4515 DISP @ DISP @ DISP " GLAD T
     O HAVE BEEN OF SERVICE"
4520 END
```

Menu 2 : current settings for control group based on analyser code 0.

```
5000 !   CODE 0 SENSE/CONTROL
5005 GOSUB 9500
5010 DATA "Resolution","400-LINE
     ","1/3 OCT","1/1 OCT","*"
5015 DATA "Display","TIME","INST
     ","A","B","INST and A","INS
     T and B","A and B","+","A+B
     "
5020 DATA "A-B","B-A","+","A/B",
     "B/A","*"
5025 DATA "Horizontal scale","LI
     N X1","LIN X4","LOG","LOG",
     "*"
5030 DATA "Vertical scale","LIN"
     ,"LIN","LOG 60dB","LOG 120d
     B","*"
5050 DATA "Plotter","ORIGIN","FU
     LL SCALE","AT CURSOR","STAR
     T PLOT","*"
5055 DATA "Averager mode","SUM",
     "DIFF","EXPON","PEAK","*"
5060 DATA "Average number-N"
5075 RESTORE 5010
5080 B$=DTB$(S1(S2))
5085 L(1)=BTD(B$[1,2])
5090 L(2)=BTD(B$[3,6])
5095 L(3)=BTD(B$[7,7])
5100 L(4)=BTD(B$[8,8])
5105 L(5)=BTD(B$[9,10])
5110 L(6)=BTD(B$[11,12])
5115 L(7)=BTD(B$[13,16])
5120 C$=DTB$(S1(6))
5125 L1=BTD(C$[16,16])
5130 L2=BTD(C$[10,10])
5135 L(3)=2*L(3)+L1
5140 L(4)=2*L(4)+L2
5145 FOR K2=1 TO 6
5150 READ E$
5155 GOSUB 9800
```

```
5160 NEXT K2
5165 READ E$@ A1=2^L(7)
5170 DISP " 7";TAB(5);E$;TAB(21)
     ;A1
5175 Q1=8 @ GOSUB 9530
5180 ON K4 GOTO 5185,5195,5205,5
     220,5230,5240,5250,9900
5185 RESTORE 5010
5186 GOSUB 9700
5187 N1=1 @ N2=2 @ S3=S2 @ K5=K1
5188 GOSUB 9850
5189 GOTO 5000
5195 RESTORE 5015
5196 GOSUB 9700
5197 N1=3 @ N2=6 @ S3=S2 @ K5=K1
5198 GOSUB 9850
5199 GOTO 5000
5205 RESTORE 5025
5206 GOSUB 9700
5207 N1,N2=7 @ S3=S2 @ K5=IP(K1/
     2)
5208 GOSUB 9850
5209 N1,N2=16 @ S3=6 @ K5=2*RMD(
     K1/2,2)
5210 GOSUB 9850
5211 GOTO 5000
5220 RESTORE 5030
5221 GOSUB 9700
5222 N1,N2=8 @ S3=S2 @ k5=IP(K1/
     2)
5223 GOSUB 9850
5224 N1,N2=10 @ S3=6 @ K5=2*RMD(
     K1/2,2)
5225 GOSUB 9850
5226 GOTO 5000
5230 RESTORE 5050
5231 GOSUB 9700
5232 N1=9 @ N2=10 @ S3=S2 @ K5=K
     1
5233 GOSUB 9850
5234 GOTO 5000
5240 RESTORE 5055
5241 GOSUB 9700
5242 N1=11 @ N2=12 @ S3=S2 @ K5=
     K1
5243 GOSUB 9850
5244 GOTO 5000
5250 RESTORE 5060
5251 READ E$
5252 CLEAR @ DISP "  ";E$
5253 FOR K2=0 TO 10
5254 DISP TAB(5);K2;TAB(19);2^K2
      @ NEXT K2
5255 DISP @ DISP "  Select new s
     etting";
5256 INPUT K5
5257 N1=13 @ N2=16 @ S3=S2
5258 GOSUB 9850
5259 GOTO 5000
5300 !     CODE 1 CONTROL/SENSE
```

Menu 2 : current settings for control group based on analyser code 1.

```
5305 GOSUB 9500
5310 DATA "Sensitivity","100mV",
     "200mV","500mV","1V","2V","
     5V","10V","*"
5315 DATA "Trigger level","-1/2"
     ,"-1/4","-1/8","-1/16","+1/
     2","+1/4","+1/8","+1/16"
5316 DATA "-TTL","+TTL","*"
5320 DATA "Test","OFF","ON","*"
5322 DATA "Input","D.C.","+","A.
     C.","I.C.P.","*"
5325 DATA "Freq/orders","EXT","I
     NT","*"
5330 DATA "Weighting window","FL
     AT","HANNING","+","AUTO","*
     "
5332 DATA "Freq. range",1,2,5,0
5335 RESTORE 5310
5340 B$=DTB$(S1(S2))
5345 L(1)=BTD(B$[1,3])
5350 L(2)=BTD(B$[9,11])
5355 L(3)=BTD(B$[12,12])
5360 L(4)=BTD(B$[13,13])
5365 L(5)=BTD(B$[14,14])
5370 L(6)=BTD(B$[15,16])
5375 L(7)=BTD(B$[4,6])
5376 L(8)=BTD(B$[7,8])
5380 C$=DTB$(S1(3))
5385 L1=BTD(C$[4,4])
5390 L2=BTD(C$[1,1])
5391 L3=BTD(C$[8,9])
5392 L(4)=L2+2*L(4)
5395 FOR K2=1 TO 6
5400 READ E$
5405 IF K2=2 THEN GOSUB 9600
5410 GOSUB 9800
5435 NEXT K2
5440 READ E$
5445 FOR K3=0 TO L(8)
5450 READ F1@ NEXT K3
5455 F1=F1*10^L(7)
5460 DISP " 7";TAB(5);E$;TAB(21)
     ;F1
5465 Q1=8 @ GOSUB 9530
5470 ON K4 GOTO 5475,5485,5495,5
     505,5520,5530,5540,9900
5475 RESTORE 5310
5476 GOSUB 9700
5477 N1=1 @ N2=3 @ S3=S2 @ K5=K1
5478 GOSUB 9850
5479 GOTO 5300
5485 RESTORE 5315
5486 GOSUB 9700
5487 GOSUB 9620
5488 N1=9 @ N2=11 @ S3=S2 @ K5=K
     1
5489 GOSUB 9850
5490 N1,N2=4 @ S3=3 @ K5=K2
5491 GOSUB 9850
5492 GOTO 5300
```

```
5495 RESTORE 5320
5496 GOSUB 9700
5497 N1,N2=12 @ S3=S2 @ K5=K1
5498 GOSUB 9850
5499 GOTO 5300
5505 RESTORE 5322
5506 GOSUB 9700
5507 N1,N2=13 @ S3=S2 @ K5=IP(K1
     /2)
5508 GOSUB 9850
5509 N1,N2=1 @ S3=3 @ K5=2*RMD(K
     1/2,2)
5510 GOSUB 9850
5511 GOTO 5300
5520 RESTORE 5325
5521 GOSUB 9700
5522 N1,N2=14 @ S3=S2 @ K5=K1
5523 GOSUB 9850
5524 GOTO 5300
5530 RESTORE 5330
5531 GOSUB 9700
5532 N1=15 @ N2=16 @ S3=S2 @ K5=
     K1
5533 GOSUB 9850
5534 GOTO 5300
5539 IF L3<2 THEN 9400
5540 IF L3<2 THEN 9400
5541 RESTORE 5332 @ CLEAR
5542 READ E$@ DISP "  ";E$
5543 L1=10 @ L2=19 @ L3=28
5544 DISP "  *";TAB(L1);" 1";TAB
     (L2);" 2";TAB(L3);" 5"
5545 DISP "--------------------
     ----------"
5546 FOR L4=0 TO 4
5547 DISP 10^L4;TAB(L1);3*L4;TAB
     (L2);3*L4+1;TAB(L3);3*L4+2
     @ NEXT L4
5548 DISP 10^5;TAB(L1);15
5549 DISP @ DISP "  Select new s
     etting";
5550 INPUT K1
5551 N1=4 @ N2=6 @ S3=S2 @ K5=IP
     (K1/3)
5552 GOSUB 9850
5553 N1=7 @ N2=8 @ S3=S2 @ K5=K1
      MOD 3
5554 GOSUB 9850
5555 GOTO 5300
5600 !   CODE 2 SENSE/CONTROL
5605 GOSUB 9500
5610 DATA "Cursor type","OFF","+
     ","SINGLE","HARMONIC","*"
5615 DATA "Cursor reading","Hz",
     "C.P.M.","*"
5620 DATA "Annotation","DATA","G
     RATICULE","NO DISPLAY","FUL
     L","*"
5625 DATA "Cursor ref.","1V","R"
     ,"+","SET R","*"
```

Menu 2 : current settings for control group based on analyser code 2.

```
5630 DATA "Cursor units","V","V2
     ","+","dB","*"
5635 DATA "Store C.R.T.","OFF","
     STORING","*"
5640 DATA "Store mode","PLOT PAG
     E","PLOT ONLY","+","AUX","*
     "
5645 RESTORE 5610
5650 B$=DTB$(S1(S2))
5655 L(1)=BTD(B$[1,2])
5660 L(2)=BTD(B$[5,5])
5665 L(3)=BTD(B$[6,7])
5670 L(4)=BTD(B$[10,11])
5675 L(5)=BTD(B$[12,13])
5680 L(6)=BTD(B$[14,14])
5685 L(7)=BTD(B$[15,16])
5690 FOR K2=1 TO 7
5695 READ E$
5700 GOSUB 9800
5705 NEXT K2
5710 Q1=8 @ GOSUB 9530
5715 ON K4 GOTO 5725,5735,5745,5
     755,5765,5775,5785,9900
5725 RESTORE 5610
5726 GOSUB 9700
5727 N1=1 @ N2=2 @ S3=S2 @ K5=K1
5728 GOSUB 9850
5729 GOTO 5600
5735 RESTORE 5615
5736 GOSUB 9700
5737 N1,N2=5 @ S3=S2 @ K5=K1
5738 GOSUB 9850
5739 GOTO 5600
5745 RESTORE 5620
5746 GOSUB 9700
5747 N1=6 @ N2=7 @ S3=S2 @ K5=K1
5748 GOSUB 9850
5749 GOTO 5600
5755 RESTORE 5625
5756 GOSUB 9700
5757 N1=10 @ N2=11 @ S3=S2 @ K5=
     K1
5758 GOSUB 9850
5759 GOTO 5600
5765 RESTORE 5630
5766 GOSUB 9700
5767 N1=12 @ N2=13 @ S3=S2 @ K5=
     K1
5768 GOSUB 9850
5769 GOTO 5600
5775 RESTORE 5635
5776 GOSUB 9700
5777 N1,N2=14 @ S3=S2 @ K5=K1
5778 GOSUB 9850
5779 GOTO 5600
5785 RESTORE 5640
5786 GOSUB 9700
5787 N1=15 @ N2=16 @ S3=S2 @ K5=
     K1
5788 GOSUB 9850
```

```
5789 GOTO 5600
5900 !    CODE 3 SENSE/CONTROL
5905 GOSUB 9500
5910 DATA "A-weighting","OFF","O
     N","*"
5920 DATA "Amplitude","OVERLOAD"
     ,"-6dB","-12dB","-18dB","-2
     4dB"
5921 DATA "-30dB","-36dB","-42dB
     ","*"
5925 DATA "Freq. exp.","PG2 500H
     z","RG1 2000Hz","+","OFF","
     *"
5930 DATA "Start A","OFF","ACTIV
     E","*"
5935 DATA "Stop A","OFF","ACTIVE
     ","*"
5940 DATA "Cont A","OFF","ACTIVE
     ","*"
5945 DATA "Transfer A-B","OFF","
     ACTIVE","*"
5950 DATA "Data capture","OFF","
     PRESENT","*"
5955 DATA "Data hold","RELEASE",
     "HOLD","*"
5960 DATA "Auto arm","OFF","ARME
     D","*"
5965 RESTORE 5910
5970 B$=DTB$(S1(S2))
5975 L(1)=BTD(B$[2,2])
5985 L(2)=BTD(B$[5,7])
5990 L(3)=BTD(B$[8,9])
5995 L(4)=BTD(B$[10,10])
6000 L(5)=BTD(B$[11,11])
6005 L(6)=BTD(B$[12,12])
6010 L(7)=BTD(B$[13,13])
6015 L(8)=BTD(B$[14,14])
6020 L(9)=BTD(B$[15,15])
6025 L(10)=BTD(B$[16,16])
6030 FOR K2=1 TO 10
6035 READ E$
6040 GOSUB 9800
6045 NEXT K2
6050 Q1=11 @ GOSUB 9530
6055 ON K4 GOTO 6060,9400,6070,6
     090,6100,6110,6120,9400,613
     0,6140,9900
6060 RESTORE 5910
6061 GOSUB 9700
6062 N1,N2=2 @ S3=S2 @ K5=K1
6063 GOSUB 9850
6064 GOTO 5900
6070 RESTORE 5925
6071 GOSUB 9700
6072 N1=8 @ N2=9 @ S3=S2 @ K5=K1
6073 GOSUB 9850
6076 IF K1>=2 THEN 5900
6078 IF K1=0 THEN K1=8 ELSE K1=1
     0
6080 N1=4 @ N2=6 @ S3=1 @ K5=IP(
     K1/3)
```

Menu 2 : current settings for control group based on analyser code 3.

```
6081 GOSUB 9850
6082 N1=7 @ N2=8 @ S3=1 @ K5=K1
     MOD 3
6083 GOSUB 9850
6084 GOTO 5900
6090 RESTORE 5930
6091 GOSUB 9700
6092 N1=10 @ N2=10 @ S3=S2 @ K5=
     K1
6093 GOSUB 9850
6094 GOTO 5900
6100 RESTORE 5935
6101 GOSUB 9700
6102 N1=11 @ N2=11 @ S3=S2 @ K5=
     K1
6103 GOSUB 9850
6104 GOTO 5900
6110 RESTORE 5940
6111 GOSUB 9700
6112 N1=12 @ N2=12 @ S3=S2 @ K5=
     K1
6113 GOSUB 9850
6114 GOTO 5900
6120 RESTORE 5945
6121 GOSUB 9700
6122 N1=13 @ N2=13 @ S3=S2 @ K5=
     K1
6123 GOSUB 9850
6124 GOTO 5900
6130 RESTORE 5955
6131 GOSUB 9700
6132 N1=15 @ N2=15 @ S3=S2 @ K5=
     K1
6133 GOSUB 9850
6134 GOTO 5900
6140 RESTORE 5960
6141 GOSUB 9700
6142 N1=16 @ N2=16 @ S3=S2 @ K5=
     K1
6143 GOSUB 9850
6144 GOTO 5900
6200 !     CODE 8 CONTROL/SENSE
6205 GOSUB 9500
6210 DATA "Expander origin"
6215 RESTORE 6210
6220 B$=DTB$(S1(S2))
6225 C$=DTB$(S1(3))
6230 L2=1-BTD(C$[3,3])
6235 A1=0
6240 FOR L=1 TO 4
6245 L1=(L-1)*4+1
6250 L(L)=15-BTD(B$[L1,L1+3])
6255 A1=A1+L(L)*10^(5-L)
6260 NEXT L
6265 A1=A1+5*L2
6270 READ E$
6275 DISP " 1";TAB(5);E$;TAB(21)
     ;A1
6280 O1=2 @ GOSUB 9530
6285 ON K4 GOTO 6300,9900
```

Menu 2 : current settings for control group based on analyser code 8.

```
6300 RESTORE 6210
6305 READ E$
6310 CLEAR @ DISP "  ";E$ @ DISP
6315 INPUT F$
6320 A$="00000" @ A$[6-LEN(F$),5
     ]=F$
6325 F$=A$[1,4] @ A$=A$[5]
6330 IF A$="5" THEN K5=0 ELSE K5
     =1
6335 N1,N2=3 @ S3=3
6340 GOSUB 9850
6345 A$="" @ S3=S2
6350 FOR L=1 TO 4
6355 N1=4*L-3 @ N2=4*L
6360 K5=15-VAL(F$[L,L])
6365 GOSUB 9850
6370 NEXT L
6375 GOTO 6200
6500 !    CODE 9 SENSE/CONTROL
6505 GOSUB 9500
6510 DATA "Ref. voltage"
6512 RESTORE 6510
6515 B$=DTB$(S1(S2))
6520 L(1)=FNC2(B$[1,7])
6525 L(2)=BTD(B$[8,16])
6530 A2=L(2)/512*2^L(1)
6535 READ E$
6540 DISP " 1";TAB(5);E$;TAB(21)
     ;@ DISP USING "D.DDE" ; A2
6545 Q1=2 @ GOSUB 9530
6550 ON K4 GOTO 6555,9900
6555 RESTORE 6510
6560 CLEAR @ READ E$
6565 DISP E$ @ DISP
6570 INPUT A2
6575 L1=5 @ L2=-32 @ L3=1
6580 L2=L2+L3*2^L1 @ L1=L1-1
6585 IF A2*2^L2>=1 THEN L3=-1 @
     GOTO 6580
6590 IF A2*2^L2<.5 THEN L3=1 @ G
     OTO 6580
6595 L1=INT(A2*2^(L2+9)+.5)
6600 A$=DTB$(L1) @ B$[8,16]=A$[8
     ,16]
6605 A$=DTB$(BINCMP(L2)+1)
6610 B$[1,7]=A$[10,16]
6615 S1(S2)=BTD(B$)
6620 GOTO 6500
```

Menu 2 : current settings for control group based on analyser code 9.

```
6800 !   CODE 10  SENSE/CONTROL
6805 GOSUB 9500
6810 DATA "Averager","OFF","RUNN
     ING","*"
6815 DATA "Int/Diff","OFF","+","
     INT","DIFF","*"
6820 DATA "Double","OFF","ON","*
     "
6825 DATA "Marker","OFF","ON","+
     ","SET","*"
6830 DATA "Vertical scale","LIN
     X","LIN /","LOG +","LOG -",
     "*"
```

Menu 2 : current settings for control group based on analyser code 10.

```
6835 RESTORE 6810
6840 B$=DTB$(S1(S2))
6845 L(1)=BTD(B$[9,9])
6850 L(2)=BTD(B$[11,12])
6855 L(3)=BTD(B$[13,13])
6860 L(4)=BTD(B$[14,15])
6865 L(5)=BTD(B$[1,1])
6870 L(6)=BTD(B$[4,8])
6875 C$=DTB$(S1(0))
6880 L1=BTD(C$[8,8])
6885 L(5)=2*L1+L(5)
6890 FOR K2=1 TO 4
6895 READ E$
6900 GOSUB 9800
6905 NEXT K2
6910 READ E$
6915 FOR K3=0 TO L(5)
6920 READ F$@ NEXT K3
6925 IF L(5)<1.5 THEN A1=2^L(6)
     @ G$="" ELSE A1=10*L(6) @ G
     $="dB"
6930 DISP " 5";TAB(5);E$;TAB(22)
     ;F$;A1;G$
6935 Q1=6 @ GOSUB 9530
6940 ON K4 GOTO 9400,6945,6955,6
     965,6980,9900
6945 RESTORE 6815
6946 GOSUB 9700
6947 N1=11 @ N2=12 @ S3=S2 @ K5=
     K1
6948 GOSUB 9850
6949 GOTO 6800
6955 RESTORE 6820
6956 GOSUB 9700
6957 N1,N2=13 @ S3=S2 @ K5=K1
6958 GOSUB 9850
6959 GOTO 6800
6965 RESTORE 6825
6966 GOSUB 9700
6967 N1=14 @ N2=15 @ S3=S2 @ K5=
     K1
6968 GOSUB 9850
6969 GOTO 6800
6980 RESTORE 6830 @ CLEAR
6982 DISP "  ";E$
6984 IF L(5)>1.5 THEN L(5)=2 ELS
     E L(5)=0
6986 DISP " 0";TAB(7);"GAIN"
6988 DISP " 1";TAB(7);"ATTENUATI
     ON"
6989 DISP @ DISP "  Select new s
     etting";
6990 INPUT K1
6992 L(5)=L(5)+K1
6994 N1,N2=1 @ S3=S2 @ K5=K1
6996 GOSUB 9850
6998 RESTORE 6830 @ CLEAR
7000 READ E$@ DISP "  ";E$
7002 FOR K3=0 TO L(5)
7004 READ F$@ NEXT K3
```

```
7006 IF L(5)>1.5 THEN 7030
7008 FOR K2=0 TO 12 STEP 2
7010 DISP K2;TAB(5);F$;2^K2;TAB(
     16);K2+1,TAB(21);F$;2^(K2+1
     )
7012 NEXT K2
7014 FOR K2=13 TO 16
7016 DISP TAB(8);K2;TAB(13);F$;2
     ^K2
7018 NEXT K2
7020 GOTO 7050
7030 FOR K2=0 TO 10
7032 DISP K2;TAB(7);F$;10*K2
7034 NEXT K2
7050 DISP @ DISP "Select new set
     ting";
7052 INPUT K5
7054 N1=4 @ N2=8 @ S3=S2
7056 GOSUB 9850
7058 GOTO 6800
7100 !     CODE 12 SENSE/CONTROL
7105 GOSUB 9500
7110 DATA "Cursor freq.","Hz","+
     ","BAND (1/3 OCT)","BAND 1/
     1 OCT","*"
7112 DATA 1,2,5,"*"
7115 RESTORE 7110
7120 B$=DTB$(S1(S2))
7125 L(1)=BTD(B$[2,10])
7130 C$=DTB$(S1(0))
7135 L1=BTD(C$[1,2])
7140 READ E$
7145 FOR K3=0 TO L1
7150 READ F$@ NEXT K3
7152 READ G$@ IF G$#"*" THEN 715
     2
7155 IF L1<1 THEN 7175
7160 IF L1>2.5 THEN L(1)=(L(1)+1
     )/3
7165 A1=L(1) @ GOTO 7230
7175 C$=DTB$(S1(3))
7180 L2=BTD(C$[8,8])
7185 L3=1-BTD(C$[3,3])
7190 C$=DTB$(S1(4))
7195 A1=0 @ IF L2=1 THEN 7230
7200 FOR L=1 TO 4
7205 L4=(L-1)*4+1
7210 L5=15-BTD(C$[L4,L4+3])
7215 A1=A1+L5*10^(5-L)
7220 NEXT L
7225 A1=A1+5*L3
7230 C$=DTB$(S1(1))
7235 L3=BTD(C$[4,6])
7240 L2=BTD(C$[7,8])
7245 FOR K3=0 TO L2
7250 READ F1@ NEXT K3
7255 F1=F1*10^L3
7260 F2=A1+L(1)/400*F1
7265 DISP " 1";TAB(5);E$;TAB(21)
     ;F2;F$
```

Menu 2 : current settings for control group based on analyser code 12.

```
7270 Q1=2 @ GOSUB 9530
7275 ON K4 GOTO 7280,9900
7280 RESTORE 7110 @ CLEAR
7285 READ E$@ DISP "  ";E$;
7290 FOR K3=0 TO L1
7295 READ F$
7300 NEXT K3 @ DISP "   ";F$
7305 DISP @ DISP "  Frequency ra
     nge permitted:-"
7310 DISP A1;"Hz to";F1+A1;"Hz"
7315 DISP @ DISP "  Select new s
     etting";
7320 INPUT F2
7325 L(1)=INT(400*(F2-A1)/F1+.5)
7330 IF L(1)<0 OR L(1)>400 THEN
     DISP " OUT OF RANGE" @ GOTO
      7315
7335 N1=2 @ N2=10 @ S3=S2 @ K5=L
     (1)
7340 GOSUB 9850
7345 GOTO 7100
7400 !   CODE 13 SENSE/CONTROL
7405 GOSUB 9500
7410 DATA "Avgs completed","*"
7413 DATA "Averager","< N","> N"
     ,"*"
7415 RESTORE 7410
7420 B$=DTB$(S1(S2))
7425 L(1)=BTD(B$[1,10])
7430 READ E$
7435 DISP " 1";TAB(5);E$;TAB(21)
     ;L(1) @ READ F$
7440 L(2)=BTD(B$[11,11])
7445 K2=2 @ READ E$
7450 GOSUB 9800
7455 Q1=3 @ GOSUB 9530
7460 ON K4 GOTO 9400,9400,9900
9400 CLEAR
9405 DISP " Impossible to change
      parameter"
9410 DISP "requested." @ BEEP @
     WAIT 5000
9415 ON S2+1 GOTO 5000,5300,5600
     ,5900,6200,6500,6800,7100,7
     400
9500 CLEAR @ DISP "  Current con
     trol settings"
9505 DISP
9510 RETURN
9530 DISP Q1;TAB(5);"No change o
     f settings"
9535 DISP
9540 DISP " Select control to be
      changed";
9545 INPUT K4
9550 RETURN
9600 IF L1=0 THEN 9610
9605 IF L(2)>3.5 THEN L(2)=9 ELS
     E L(2)=8
9610 RETURN
```

Menu 2 : current settings for control group based on analyser code 13.

```
9620 IF K1<7.5 THEN K2=0 ELSE K1
     =K1-5 @ K2=1
9625 RETURN
```

Displays all possible settings as given by appropriate data statements.

```
9700 READ E$@ K1,K2=-1
9705 CLEAR @ DISP "  ";E$
9710 READ F$@ K1=K1+1 @ IF F$="+
     " THEN 9710
9715 IF F$="*" THEN 9730
9717 K2=K2+1 @ K(K2)=K1
9720 DISP TAB(5);K2;TAB(20);F$
9725 GOTO 9710
9730 DISP @ DISP "  Select new s
     etting";
9735 INPUT K2
9740 K1=K(K2)
9745 RETURN
```

Selects and displays curent settings from appropriate data statement.

```
9800 FOR K3=0 TO L(K2)
9805 READ F$@ NEXT K3
9810 DISP K2;TAB(5);E$;TAB(22);F
     $
9815 READ F$
9820 IF F$#"*" THEN 9815
9825 RETURN
9850 A$=DTB$(K5) @ B$=DTB$(S1(S3
     ))
9855 A$=A$[16-(N2-N1),16]
9860 B$[N1,N2]=A$ @ S1(S3)=BTD(B
     $)
9870 RETURN
```

Sends all front panel control instructions to analyser.

```
9900 RESTORE 120
9905 FOR K1=0 TO 7
9910 READ S2$
9915 S1$=DTH$(S1(K1))&S2$
9920 OUTPUT N ;S1$
9925 NEXT K1 @ GOTO 3000
```

```
 100 COM INTEGER N,S1(10)
 110 DIM N1$[40]
 120 ENABLE KBD 229
130 INTEGER L1,L2,L3,L4,L5,K1,K2
    ,K3,K4,K5,N1,N2,S,F
140 SHORT V
150 DEF FNC2(A$)
160 C1=BTD(A$) @ C3=2^LEN(A$)
```

2's complement conversion routine.

```
170 C4=C3/2-.5 @ IF C1>C4 THEN C
    1=C1-C3
180 FNC2=C1 @ FN END
200 DEF FNL0(Z) = 10^(LGT(W1)+Z/
    S*LGT(W2/W1))
220 DEF FNL1(Z) = W1+Z/S*(W2-W1)
400 DATA 1,2,5
410 DATA "FLAT","HANNING","+","A
    UTO"
420 DATA 2000,500
430 DATA 0,1,2,3,8,9,A,C,D
1000 CLEAR @ DISP "  Data aquisi
     tion and storage"
1005 DISP @ DISP "Current spectr
     al or time data"
1010 DISP "may be stored,or furt
     her data "
1015 DISP "may be aquired under
     HP-85       control"
1020 DISP @ DISP "K1 for current
      data"
1025 DISP "K2 for computer contr
     ol"
1030 ON KEY# 1 GOTO 1045
1035 ON KEY# 2 GOTO 4000
```

Selects current display contents or computer control.

```
1040 GOTO 1040
1045 GOSUB 7000
1160 B$=DTB$(S1(0))
1165 L3=BTD(B$[3,6])
1170 IF L3=0 THEN L4=8300 ELSE L
     4=3300
1175 B$=DTB$(S1(1))
1180 L5=BTD(B$[1,3])
1185 RESTORE 400
1190 FOR K1=0 TO L5 MOD 3
1195 READ L1
1200 NEXT K1
1205 A2=L1*10^(L5 DIV 3-1)
1210 L5=BTD(B$[7,8])
1215 RESTORE 400
1220 FOR K1=0 TO L5
1225 READ L1
1230 NEXT K1
1235 L5=BTD(B$[4,6])
1240 F1=L1*10^L5
1245 B$=DTB$(S1(3))
1250 L1=BTD(B$[8,9])
1255 IF L1=3 THEN F2=0 @ GOTO 12
     95
1260 L1=BTD(B$[3,3])
1265 IF L1=1 THEN F2=0 ELSE F2=5
1270 B$=DTH$(S1(4))
```

```
1275 FOR K2=1 TO 4
1280 L3=15-HTD(B$[K2,K2])
1285 F2=F2+L3*10^(5-K2)
1290 NEXT K2
1295 B$=DTB$(S1(5))
1300 L1=FNC2(B$[1,7])
1305 L2=BTD(B$[8,16])
1310 A3=L2/512*2^L1
1315 CREATE N2$,1,L4
1320 ASSIGN# 1 TO N2$
1325 IF L4=8300 THEN 2000
1330 B$=DTB$(S1(0))
1335 L1=BTD(B$[11,12])
1340 N1=2^BTD(B$[13,16])
1345 IF L1=2 THEN 1365
1350 DISP @ DISP " Waiting for a
     veraging to end."
1355 L2=SPOLL(N) DIV 2 MOD 2
1360 IF L2=0 THEN 1355
1365 CLEAR @ DISP "   Data trans
     fer proceding"
1370 B$=DTB$(S1(1))
1375 L3=BTD(B$[15,16])
1377 RESTORE 410
1380 FOR K1=0 TO L3
1385 READ C$
1390 NEXT K1
1395 PRINT# 1 ; "S",400,N1$,C$,F
     1,F2,A3
1400 OUTPUT N ;"T"
1405 ENTER N ; A$
1410 B$=DTB$(HTD(A$[1,4]))
1415 N2=BTD(B$[1,10])
1420 IF L1=2 THEN A2=A2/(1-EXP(-
     (N2/N1)))
1425 ENTER N USING "%,%K" ; A$
1430 IF A$="Ā" THEN 5100
1435 B$=DTB$(HTD(A$[1,4]))
1440 L1=FNC2(B$[1,6]) @ L2=FNC2(
     B$[7,15])
1445 V=SQR(L2/256*2^L1)*A2
1450 PRINT# 1 ; V
1455 GOTO 1425
2000 PRINT# 1 ; "T",1024,N1$,F1,
     F2
2005 OUTPUT N ;"T"
2010 ENTER N USING "%,%K" ; A$
2015 IF A$="Ā" THEN 5100
2020 B$=DTB$(HTD(A$[1,4]))
2025 V=A2*1.4*FNC2(B$[1,12])/204
     8
2030 PRINT# 1 ; V
2035 GOTO 2010
4000 CLEAR @ DISP " Computer con
     trolled data        aquisiti
     on"
4010 DISP @ DISP "Maximum freque
     ncy required";
4015 INPUT W2
4020 DISP "Minimum frequency req
     uired";
```

Initialises tape drive.

Reads spectral data from analyser and stores it on tape.

Reads time data from analyser and stores it on tape.

For computer control : takes data requirements from keyboard and decides on frequency range necessary.

```
4025 INPUT W1
4030 RESTORE 420
4035 READ R1,R2
4040 RESTORE 400
4045 READ L(0),L(1),L(2)
4050 W=W2
4055 GOSUB 8000
4060 R3=L(K1)*10^K2
4062 IF R3>100000 THEN R3=100000
4065 R=MIN(R1,MIN(R2,R3))
4070 DISP "Narrowest bandwidth f
     ilter"
4075 DISP " Δf =";R/400;"Hz"
4080 DISP "If this is satisfacto
     ry press K1"
4085 DISP "To change frequency p
     ress K2"
4090 ON KEY# 1 GOTO 4105
4095 ON KEY# 2 GOTO 4000
4100 GOTO 4100
4105 DISP "What filter bandwidth
      do you    require";
4110 INPUT D1
4115 IF D1<R/400 THEN 4070
4120 IF D1<R3/400 THEN 4155
4122 RESTORE 400 @ M1=3
4125 FOR K1=0 TO 2
4127 READ L(K1)
4130 L(K1)=L(K1)/400
4135 NEXT K1
4140 W=D1/2
4145 GOSUB 8000
4147 D2=L(K1)*10^K2
4148 IF D2>250 THEN D2=250
4150 GOTO 4165
4155 IF D1>MAX(R1,R2)/400 THEN D
     2=MAX(R1,R2)/400 @ GOTO 416
     2
4160 D2=MIN(R1,R2)/400
4162 IF D2=R1/400 THEN M1=1 ELSE
      M1=0
4165 DISP "Filter bandwidth Δf =
     ";D2;"Hz"
4170 DISP "If this is satisfacto
     ry press K1"
4175 DISP "To change bandwidth p
     ress K2"
4180 ON KEY# 1 GOTO 4195
4185 ON KEY# 2 GOTO 4105
4190 GOTO 4190
4192 R=D2*400
4194 W1=MAX(W1,D2)
4195 ON KEY# 1,"LINEAR" GOTO 810
     0
4200 ON KEY# 2," LOG" GOTO 8150
4205 CLEAR @ KEY LABEL
4210 DISP "Logarithmic or linear
      freqency  scale" @ DISP
4215 GOTO 4215
4220 DISP "How many averages per
      data point"
```

```
4225 INPUT L5@ K3=0
4230 K3=K3+1
4235 A4=2^K3
4240 IF A4<L5 THEN 4230
4245 DISP @ DISP " ";A4;"average
     s will be made"
4250 S2=0
4255 N1=1 @ N2=2 @ K5=0
4260 GOSUB 8200
4265 N1=3 @ N2=6 @ K5=2
4270 GOSUB 8200
4272 N1=7 @ N2=7 @ K5=0
4273 GOSUB 8200
4275 N1=11 @ N2=12 @ K5=0
4280 GOSUB 8200
4285 N1=13 @ N2=16 @ K5=K3
4290 GOSUB 8200
4295 GOSUB 8250
4300 S2=1 @ N1=15 @ N2=16 @ K5=3
4305 GOSUB 8200
4307 N1=1 @ N2=3 @ K5=0
4308 GOSUB 8200
4310 GOSUB 8250
4315 S2=2 @ N1=1 @ N2=2 @ K5=0
4320 GOSUB 8200
4325 GOSUB 8250
4330 GOSUB 8300
4335 B$=DTB$(S1(3))
4340 IF B$[15,16]="00" THEN 4365
4345 S2=3 @ N1,N2=15 @ K5=1
4350 GOSUB 8200
4355 GOSUB 8250
4360 GOTO 4330
4365 S2=3 @ N1=8 @ N2=9 @ K5=M1
4370 GOSUB 8200
4372 N1,N2=3 @ K5=1
4373 GOSUB 8200
4375 GOSUB 8250
4380 S2=6 @ N1=14 @ N2=15 @ K5=0
4385 GOSUB 8200
4390 N1,N2=16 @ K5=0
4395 GOSUB 8200
4400 GOSUB 8250
4410 S2=1
4415 N1=4 @ N2=6 @ K5=INT(LGT(R)
     )
4420 GOSUB 8200
4425 L1=R/10^K5
4430 IF L1=5 THEN L1=3
4435 N1=7 @ N2=8 @ K5=L1-1
4440 GOSUB 8200
4445 GOSUB 8250
4450 GOSUB 7000
4452 IF M2=0 THEN Q$="LIN" ELSE
     Q$="LOG"
4455 CREATE N2$,1,100+16*S
4460 ASSIGN# 1 TO N2$
4465 PRINT# 1 ; Q$,S+1,N1$,D2,A4
4466 PRINT @ PRINT "  Data file
     - ";N2$
```

Sends setting up instructions to analyser.

Initialises tape drive.

```
4468 PRINT @ PRINT N1$
4470 PRINT @ PRINT Q$;" scale wi
     th";S+1;"data points"
4472 PRINT @ PRINT "  Δt =";D2;"
     Hz   ";A4;"averages"
4473 PRINT @ PRINT "  Freq /Hz
          Voltage /V" @ PRINT
4475 K5=0
4477 K1=0
4480 FOR K2=0 TO 20
4485 GOSUB 8300
4490 A$=DTB$(S1(3))
4495 IF A$[5,7]="000" THEN K1=K1
     +1
4500 NEXT K2
4505 IF K1>0 THEN K5=K5+1 ELSE 4
     530
4510 IF K5>7 THEN GOTO 8600
4512 S2=1 @ N1=1 @ N2=3
4515 GOSUB 8200
4520 GOSUB 8250
4525 GOTO 4477
4530 IF M1#3 THEN 5000
4535 F=0 @ K2=0
4540 WAIT INT(1000/D2)
4545 GOSUB 8750
4550 GOSUB 8350
4555 GOSUB 8400
4560 GOTO 5100
5000 K2=0
5005 GOSUB 8500
5010 F=10*(MAX(A5-R/5,0) DIV 10)
5015 GOSUB 8700
5020 WAIT 100+1.1*INT(1000/D2)
5025 GOSUB 8750
5030 GOSUB 8350
5035 GOSUB 8400
5040 IF K2>S THEN 5100
5045 F=10*(MAX((A5+A6)/2,A5-R/5)
      DIV 10)
5050 GOTO 5015
5100 ASSIGN# 1 TO *
5105 CLEAR @ DISP " K1 to change
      analyser controls"
5110 DISP " K2 to store further
     data"
5112 DISP " K3 to end program"
5115 ON KEY# 1,"CONTROL" GOTO 52
     00
5120 ON KEY# 2," DATA" GOTO 100
5122 ON KEY# 3," END " GOTO 5150
5125 KEY LABEL
5130 GOTO 5130
5150 OUTPUT N ;"L"
5155 CLEAR @ DISP @ DISP @ DISP
5160 DISP "  Glad to have been o
     f service"
5165 END
5200 DISP @ DISP "Please be pati
     ent while next    part of p
     rogram is being        init
     ialised"
```

Prints out information on built-in printer.

Sets input sensitivity of analyser.

Takes data from analyser and records it on tape and on printer.

Choice of further action.

```
5205 WAIT 4000
5210 CHAIN "NIC #2"
7000 CLEAR @ DISP "Insert data t
     ape into tape drive"
7005 ON ERROR GOTO 7007 @ GOTO 7
     010
7007 IF ERRN#62 THEN DISP "TAPE
     ERROR" @ PAUSE
7010 REWIND
7015 OFF ERROR
7020 PRINT ALL
7025 ON ERROR GOTO 7070
7030 PRINT @ CAT @ NORMAL
7035 OFF ERROR
7040 DISP @ DISP "Is this the ta
     pe to be used";
7045 INPUT Q$@ IF Q$[1,1]="Y" TH
     EN 7090
7050 DISP "Replace tape in tape-
     drive "
7055 DISP "Press key K1 when rea
     dy."
7060 ON KEY# 1 GOTO 7005
7065 GOTO 7065
7070 IF ERRN#73 THEN 7007
7080 ERASETAPE
7085 GOTO 7030
7090 CLEAR @ DISP "Give informat
     ion to go with"
7095 DISP "data (<40 chars)";
7100 INPUT N1$
7105 DISP "Give name for data fi
     le";
7110 INPUT N2$@ L1=MIN(6,LEN(N2$
     )) @ N2$=N2$[1,L1]
7115 RETURN
8000 K2=0
8005 K1=0
8010 IF L(K1)*10^K2>=W THEN RETU
     RN
8015 K1=K1+1
8020 IF K1=3 THEN K2=K2+1 @ GOTO
      8005 ELSE 8010
8100 M2=0
8105 DISP "How many data points
     required";
8110 INPUT S
8115 GOTO 4220
8150 M2=1
8155 DISP "How many data points
     per decade";
8160 INPUT L5
8165 S=CEIL(L5*LGT(W2/W1))
8170 DISP "Total no. of points =
     ";S
8175 GOTO 4220
8200 A$=DTB$(K5)
8205 B$=DTB$(S1(S2))
8210 A$=A$[16-(N2-N1),16]
8215 B$[N1,N2]=A$
```

Subroutine for setting up and naming data file on tape.

Sets number of spectral data points to be stored.

```
8220 S1(S2)=BTD(B$)
8225 RETURN
8250 RESTORE 430
8255 FOR K3=0 TO S2
8260 READ C$@ NEXT K3
8265 B$=DTH$(S1(S2))&C$
8270 OUTPUT N ;B$
8275 RETURN
8300 OUTPUT N ;"S" @ S2=0
8305 ENTER N USING "%,%K" ; A$
8310 IF A$="N̄" THEN RETURN
8315 S1(S2)=HTD(A$[1,4])
8320 S2=S2+1 @ GOTO 8305
8350 CLEAR @ DISP "  Waiting for
      averaging to end" @ WAIT 1
     00
8355 ON 1+BIT(SPOLL(N),1) GOTO 8
     355,8360
8360 RETURN
8400 OUTPUT N ;"T" @ K1=1
8405 ENTER N ; A$
8410 B$=DTB$(HTD(A$[1,4]))
8415 L2=BTD(B$[11,13]) MOD 3+1
8420 IF L2=3 THEN L2=5
8425 L3=BTD(B$[11,13]) DIV 3-1
8430 A2=L2*10^L3
8435 GOSUB 8500
8440 ENTER N USING "%,%K" ; A$
8445 IF A$="N̄" THEN RETURN
8450 IF F+K1*D2>=A5 AND K2<=S TH
     EN GOSUB 8550
8455 K1=K1+1
8460 GOTO 8440
8500 IF M2=0 THEN A5=FNL1(K2)
8505 IF M2=1 THEN A5=FNL0(K2)
8510 RETURN
8550 PRINT# 1 ; F+K1*D2
8555 B$=DTB$(HTD(A$[1,4]))
8560 L1=FNC2(B$[1,6])
8565 L2=FNC2(B$[7,15])
8570 V=SQR(L2/256*2^L1)*A2
8575 PRINT# 1 ; V
8580 K2=K2+1 @ A6=A5
8582 PRINT "   ";F+K1*D2;TAB(16);
     V
8585 GOSUB 8500
8590 RETURN
8600 CLEAR @ DISP "     INPUT LE
     VEL TOO HIGH"
8605 BEEP 30,400
8610 DISP "PRESS 'CONT' WHEN LEV
     EL IS RESET"
8615 PAUSE
8620 K5=0
8625 GOTO 4510
8650 CLEAR @ DISP "     INPUT LE
     VEL TOO LOW"
8655 BEEP 30,400
8660 DISP "PRESS 'CONT' WHEN LEV
     EL IS RESET"
```

Selects appropriate code for instructions to analyser and sends them.

Reads in control settings.

Examines status byte of analyser to determine whether averaging is complete or not.

Reads in spectral data, decides if data is required, and stores this data on tape and on printer.

```
8665 PAUSE
8670 K5=0
8675 GOTO 4510
8700 A$=VAL$(F DIV 10)
8705 B$="FFFF8"
8710 L1=LEN(A$)
8715 FOR K4=1 TO L1
8720 C$=DTH$(15-HTD(A$[K4,K4]))
8725 B$[4-L1+K4,4-L1+K4]=C$[4,4]
8730 NEXT K4
8735 OUTPUT N ;B$
8740 RETURN
8750 S2=3 @ N1,N2=10 @ K5=1
8755 GOSUB 8200
8760 GOSUB 8250
8765 RETURN
```

Sets frequency expansion origin.

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